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his own if he knows that he has made any. If no answers are given, the student works a problem and does not know whether it is right or wrong until he comes to class. There are problems, like problems in finding the integral roots of equations or problems in factoring in elementary algebra, which are of such a nature that the answers, if given, supply the student with too much information as to the method of working the problem. But there are not many such in the calculus. Furthermore, if the answers are not given, and if the same textbook is used for several years, the number of second-hand books in use gets to be considerable and these have many of the answers marked in by students. Then the students in the class are not all on the same footing with respect to answers. Some of them have the answers and some do not. This use of second-hand books, with many answers marked in, is likely to interfere with the use of this book of problems in tests as is suggested by the author in the quotation given above.

The book is much more pretentious than the "Problems in Differential Calculus" published by W. E. Byerly in 1895. A good bibliography of problem books in the calculus, mostly in German, is to be found in the *Bulletin of the American Mathematical Society*, June, 1914.

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## PROBLEMS AND SOLUTIONS.

EDITED BY B. F. FINKEL AND R. P. BAKER.

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### PROBLEMS FOR SOLUTION.

#### ALGEBRA.

**452. Proposed by CLIFFORD N. MILLS, Brookings, S. Dak.**

Find in the form of a continued fraction the positive root of the equation  $x^3 - 2x - 5 = 0$ .

**453. Proposed by A. J. KEMPNER, University of Illinois.**

Is the series whose terms are the reciprocals of all positive integers not containing the figure 0, convergent or divergent?

**454. Proposed by C. N. SCHMALL, New York City.**

Prove that a number is divisible by nine if, and only if, the sum of its digits is divisible by nine.

#### GEOMETRY.

**483. Proposed by LAENAS G. WELD, Pullman, Illinois.**

A circle is inscribed in a triangle. In each of the three spandrils exterior to the circle another circle is inscribed; in the remaining spandrils three other circles; and so on ad infinitum. Show that the sum of the areas of these circles is given by the formula:

$$\Sigma = \frac{\pi \Delta^2}{4 s^2} \left[ \frac{1}{\sin (A/2)} + \frac{1}{\sin (B/2)} + \frac{1}{\sin (C/2)} - 2 + \sin \frac{A}{2} + \sin \frac{B}{2} + \sin \frac{C}{2} \right].$$

**484. Proposed by NORMAN ANNING, Chilliwack, B. C.**

Show that when spheres of uniform size are packed in the closest possible manner there is, in the interior of the mass, about 26 per cent. of voids.

**485. Proposed by NATHAN ALTSHILLER, University of Colorado.**

Find the surface generated by the orthogonal projection of a given line upon a variable plane turning about a fixed axis.

## CALCULUS.

**403. Proposed by C. N. SCHMALL, New York City.**

A paraboloid of revolution generated by the curve  $x^2 = 4ay$ , contains a quantity of water such that if a sphere of radius  $r$  be dropped to the bottom, it will just be covered by the water. Show that if the volume of water used in this experiment is to be a *minimum*, then we must have  $a = r/6$ .

**404. Proposed by B. J. BROWN, Victor, Colorado.**

Solve the differential equation,  $(x^2 - y^2)(1 + dy/dx) = 2xy(1 - dy/dx)$ .

## MECHANICS.

**321. Proposed by E. J. MOULTON, Northwestern University.**

The attraction,  $A$ , in any given direction, due to a homogeneous sphere, on a particle at the center of the sphere, using the Newtonian law, is obviously zero. Find the error in the following method of computing  $A$ . Take cylindrical coördinates with origin at the center of the sphere; let the  $z$ -axis extend in the direction of the attraction to be computed, and let  $r$ ,  $\theta$  be the polar coördinates used. Let  $\delta$  be the density and  $R$  the radius of the sphere, and  $k$  the constant of gravitation. Then

$$A = \int_{z=-R}^{z=R} \int_{r=0}^{r=\sqrt{R^2-z^2}} \int_{\theta=0}^{\theta=2\pi} \frac{k\delta r z d\theta dr dz}{[r^2 + z^2]^{3/2}} \quad (1)$$

$$= 2\pi k\delta \int_{z=-R}^{z=R} \left[ \frac{-z}{(r^2 + z^2)^{1/2}} \right]_{r=0}^{r=\sqrt{R^2-z^2}} dz \quad (2)$$

$$= 2\pi k\delta \int_{-R}^R \left[ \frac{-z}{R} + 1 \right] dz \quad (3)$$

$$= 4\pi k\delta R. \quad (4)$$

**322. Proposed by FRANK R. MORRIS, Glendale, Calif.**

A pole of uniform size and weight throughout its length stands in a vertical position. The height of the pole is  $h$  and weight  $w$ . It hinges at the base and falls, passing through a horizontal position. At the moment it reaches the horizontal position, how far from the base is the maximum vertical force tending to break the pole? How great is this force? What is the horizontal force at the same position in the pole?

**323. Proposed by CLIFFORD N. MILLS, Brookings, S. Dak.**

Two equal bodies are placed on a rough inclined plane, being connected by a light inelastic string; if the coefficients of friction are respectively  $\frac{1}{2}$  and  $\frac{1}{4}$ , show that they will both be on the point of motion when the inclination of the plane is  $\sin^{-1} (7/25)$ .

## NUMBER THEORY.

**239. Proposed by HAROLD T. DAVIS, Colorado Springs, Colorado.**

Give a general method for determining the solution in integers of the equation

$$x^r - 10xy - (n+1) + y = 0,$$

where  $r$  and  $n$  are positive integers.

**240. Proposed by J. W. NICHOLSON, Louisiana State University.**

If the roots of  $x^3 - px + q = 0$  are rational, prove that  $4p - 3x^2$  is a perfect square.